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The usability of shock index and lactate in predicting mortality in multitrauma patients presenting to the emergency department

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ABSTRACT

Objectives: This study was conducted to evaluate two simple and quickly assessed parameters such as shock index (SI) and lactate to predict in-hospital mortality in multi-trauma patients admitted to the emergency department (ED).

Material and Methods: The study included a total of 93 patients who presented to the ED with multitrauma. In our retrospective study, SI was calculated by taking blood pressure and pulse values from the files of the patients recorded at the time of admission to the ED, and lactate values obtained from blood gas were recorded. The results were compared with the in-hospital mortality rates after admission. SI ($p<0.001$) and lactate ($p<0.001$) values in patients discharged as exitus were significantly higher ($p<0.05$). The predictive diagnostic value of SI and lactate levels in terms of mortality in the patients included in the study was analyzed by using ROC curve analysis.

Results: The area under the ROC curve for SI was 0.738. The SI cut-off value for patients' mortality findings was 1.14. The area under the ROC curve for the lactate value was 0.941. The lactate cut-off value for mortality findings was 4.5.

Conclusion: In conclusion, SI and lactate values obtained at ED admission can be used to predict mortality in multitrauma patients.

Keywords: Multitrauma, Shock index, Lactate, Emergency Department, Mortality

INTRODUCTION

Trauma is a public health problem that causes serious economic and medical burdens worldwide (1). The arrival of trauma patients with serious injuries, the presence of many symptoms at the same time, and the rapid and variable progression of the disease pose the risk of death at any time. The three distinct death peaks occur within the first hour in approximately 50% of trauma patients, within the first 3 hours in approximately 30%, and within 1-4 weeks in approximately 15%. The first two death peaks with the highest rates occur in the crime scene and emergency department(ED), where the first few hours are spent in the early stage of trauma. Therefore, it is very important to predict early deaths quickly and to identify high-risk trauma patients to reduce the rate of trauma-related deaths. Activating the trauma team and preparing them for surgery as soon as necessary is of vital importance for the prevention of mortality.

The data that can be obtained in triage in the ED are vital parameters. The shock index (SI), which is the ratio of heart rate to systolic pressure, can be easily calculated based on vital signs and has proven to be a good predictor in clinical practice. A study has shown that a high SI value recorded in the ED increases the probability of both hospitalization and inpatient mortality in the general adult ED population (2). Some studies suggest the use of SI to predict the prognosis of trauma patients (3-5). The increase in SI in trauma patients mainly indicates acute hypovolemia and circulatory failure and is significantly associated with hospitalization, intensive care, mechanical ventilation, and the risk of mortality (6,3).

It has been reported that determining the treatment according to the early lactate value reduces mortality in critically ill patients (7). In addition, lactate has been reported as a useful prognostic indicator of occult hypoperfusion

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and a predictor of outcome in the acute care setting and following trauma (8,9). Serum lactate values are commonly used in the treatment of sepsis and trauma. Serial lactate measurements are also important during the treatment of these patients. As lactate has an estimated half-life of 20 minutes, the persistence of lactic acidosis may indicate a persistent hypoxic state. Serial lactate measurements may be useful in predicting sepsis and death in trauma patients, and lactate clearance (using serial lactate measurements) may provide data on the adequacy of resuscitation and prognosis for trauma patients (10,11).

Therefore, our study was conducted to evaluate simple, useful, and quick methods that can quickly predict mortality in multitrauma patients in the ED. In the study, we aimed to investigate the predictions of SI and lactate, which can be easily and quickly assessed in the ED, in detecting in-hospital mortality in multitrauma patients. Thus, we tried to contribute to early diagnosis and treatment planning with accurate triage in this patient group with a high mortality rate.

MATERIAL AND METHOD

This study was carried out by reviewing the files of multi-trauma patients aged 18 and over who visited Balıkesir University Medical Faculty Hospital between February 1, 2019 and December 1, 2021. Approval of the Balıkesir University Medical Faculty Clinical Researches Ethics Committee was obtained for the retrospective study (Decision date: 08.12.2021 and issue: 2021/265). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Patients who were younger than 18 years of age, had non-traumatic organic pathologies in addition to trauma, or were referred to another hospital for any reason were not included in the study. In the study, patients' vital values (beats per minute (BPM), blood pressure (BP), lactate levels in blood gas) were obtained from archive records. Data were collected by trained researchers. SI score was calculated from vital parameters and recorded. The blood pressure values of all patients were evaluated with the Erka D.83646 Bad Tölz sphygmomanometer and blood gas values with epoc Reader 6246 device. Patients' age, gender, and final results (alive, exitus) during hospitalization were recorded. Patients whose data were not available in the records were excluded from the study.

Statistical Analysis

The SPSS (Statistical Package for the Social Sciences) 25.0 software package was used for the statistical analysis of the data. Categorical measurements were presented as numbers and percentages, and continuous measurements as mean and standard deviation values (median and minimum-maximum where appropriate). A chi-square test was used to compare categorical data. Shapiro-Wilk test was used to determine the normality of the parameters in the study. The independent samples t-test was used for normally distributed parameters, and the Mann Whitney U test was used for non-normally distributed parameters. The sensitivity and specificity values of SI and lactate values were calculated based on the mortality findings of the patients included in the study, and the cut-off value was determined by examining the area under the ROC curve. Statistical significance level was taken as $p<0.05$ in all tests.

RESULTS

Most of the patients admitted to the ED are caused by traffic accidents. The rates of admission to the ED and mortality are given in **Figure-1**.

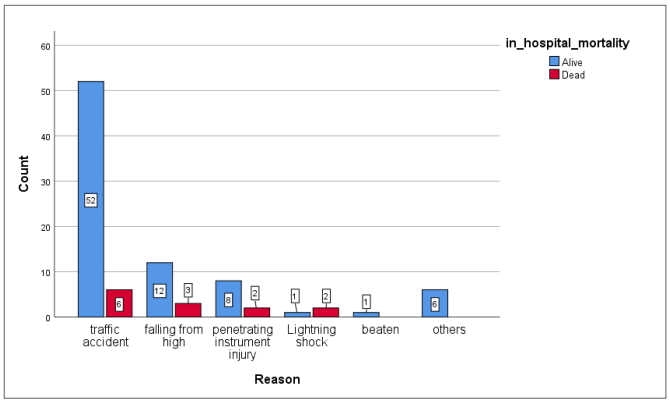

Figure-1: Causes of trauma and in-hospital mortality rates according to the cause

Demographic and basic characteristics of the patients are as in the table (**Table-1**). SI ($p<0.001$) and lactate level ($p<0.001$) findings were significantly higher in patients who were exitus ($p<0.05$). It was observed that the lactate level ($p<0.001$) and SI value ($p<0.001$) of the patients who were exitus were significantly higher than the patients who survived ($p<0.05$) (**Table-2**).

Table 1. Demographics and baseline characteristics of patients

	Alive (n=80) n(%)	Dead (n=13) n(%)	Total (n=93) n(%)
Gender			
Male	61 (76.3)	9 (69.2)	70 (75.3)
Female	19 (23.8)	4 (30.8)	23 (24.7)
Age	43.1±17.1 39 (20-89)	50.0±21.8 45 (22-81)	44.0±17.8 40 (20-89)
Pulse rate	92.3±17.9 92 (44-130)	112.9±16.4 115 (67-132)	95.2±19.1 95 (44-132)
Systolic pressure	121.8±23.8 120 (60-185)	112.5±31.8 100 (70-166)	120.5±25.1 120 (60-185)
Diastolic pressure	74.0±14.8 70 (40-118)	71.5±18.3 70 (50-109)	73.7±15.3 70 (40-118)
Lactate level	2.37±1.3 2.4 (0.5-6.6)	8.95±3.5 8.7 (1.2-14.2)	3.29±2.9 2.4 (0.5-14.2)

Data given as *mean±standard deviation, &median (minimum-maximum) or #n (%)

Table 2: Comparison of patient characteristics in terms of in-hospital mortality

	Alive (n=80)	Dead (n=13)	Total (n=93)	p
	n(%)	n(%)	n(%)	
Shock Index (SI)				
Low	72 (90)	6 (46,2)	78 (83,9)	<0,001
High	8 (10)	7 (53,8)	15 (16,1)	
Lactate Level				
Low	77 (96,3)	1 (7,7)	78 (83,9)	<0,001
High	3 (3,8)	12 (92,3)	15 (16,1)	
Lactate level	2,37±1,3 2,4 (0,5-6,6)	8,95±3,5 8,7 (1,2-14,2)	3,29±2,9 2,4 (0,5-14,2)	<0,001
Shock Index (SI)	0,79±0,25 0,74 (0,34-1,67)	1,08±0,36 1,2 (0,64-1,86)	0,83±0,28 0,76 (0,34-1,86)	<0,001

The predictive diagnostic value of SI and lactate levels in terms of mortality in the patients included in the study was evaluated by the ROC curve analysis. The area under the ROC curve for SI was 0.738 (95% confidence interval (CI): 0.637-0.824; p=0.002). The SI cut-off value for patients' mortality findings was 1.14 (specific: 53.85%, 95% CI: 25.1-80.8, sensitive: 91.25%, 95% CI: 82.8-96.4). The area under the ROC curve for lactate was 0.941 (95% CI: 0.873-0.979; p<0.001). The lactate cut-off (threshold) value for mortality findings was 4.5 (specificity: 92.31%, 95% CI: 64.0-99.8, sensitivity: 96.25%, 95% CI: 89.4-99.2) (**Table-3, Figure-2, Figure-3**).

Table 3. ROC curve analysis results for SI and lactate

	Shock Index (SI)	Lactate Level
AUC	0.738	0.941
95%-Cl (%)	0.637-0.824	0.873-0.979
Cut-off	>1.14	>4.5
Specificity	53.85	92.31
95%-Cl (%)	25.1-80.8	64.0-99.8
Sensitivity (%)	91.25	96.25
95%-Cl (%)	82.8-96.4	89.4-99.2
p	0.002	<0.001

AUC: Area under the curve, CI: Confidence interval

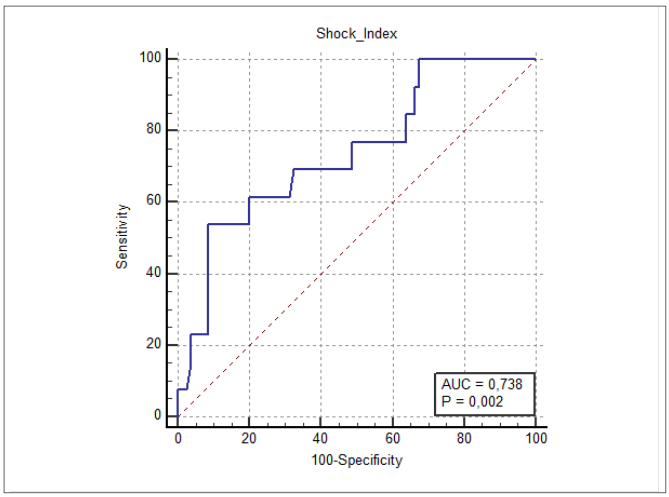

Figure-2: ROC curves of SI for hospital mortality

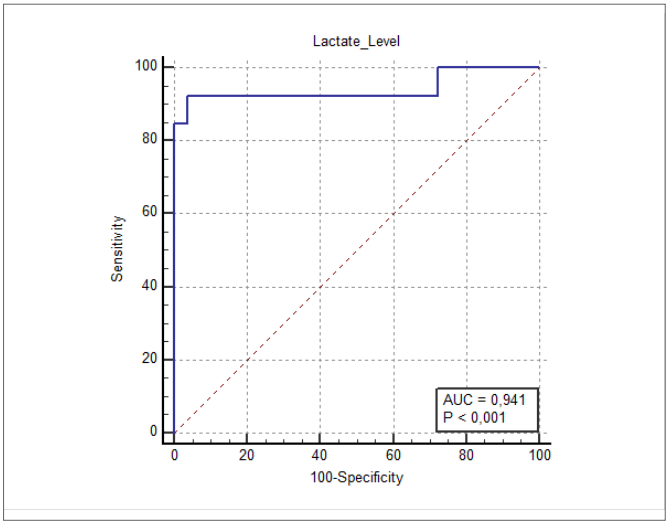

Figure-2: ROC curves of SI for hospital mortality

DISCUSSION

Our study defined the use of SI and lactate as an independent predictor of mortality in multitrauma patients in the ED. The use of SI and lactate may be considered as a good choice for the assessment and triage of the severity of multitrauma patients in the ED.

The SI is a classical indicator that is more sensitive than traditional vital signs for assessing shock. Numerous studies have been conducted on the practical value of SI in trauma patients in recent years. A retrospective cohort study of 16269 trauma patients elucidated the relationship between prehospital SI and hospital stay, length of stay in intensive care and mechanical ventilation, and the use of blood products. It has been shown that patients with an SI value of > 0.9 have a higher risk of transfer to the intensive care unit, emergency surgery, or death (3). A study of 1419 patients indicated that after fluid resuscitation with 1 liter of crystalloid, patients with a high SI value had a higher blood transfusion demand, higher mortality, and worse outcomes (12). This result was also confirmed by a study showing that there would be a significant increase in mortality if the SI did not improve within six hours (13). One study reported that an abnormally elevated SI measured at any time indicated that trauma patients had a higher risk of death within 28 days (14). Charlie et al. (15) reported that an SI value of >0.9 predicted a worse prognosis after trauma. All of these studies highlight the finding of a statistically significant association between SI and mortality in trauma patients. In our study, SI>1.14 was found to be significant in terms of predicting mortality in multitrauma patients. The use of SI as an indicator of severity and poor prognosis in trauma patients is indisputable, and abnormally high levels often indicate a worse outcome in trauma patients. However, in our study, it was evaluated to determine in-hospital mortality, not premature death at the time of stay in the ED.

Lactate has been shown to be a prognostic biomarker in trauma, even in patients with normal vital signs (16,17). This relationship has been confirmed in experimental studies (18,19). High blood lactate levels have been demonstrated in all types of shock (20). Alcohol or drug use, which is frequently encountered in trauma patients, does not change the estimation accuracy of baseline blood lactate levels (21). In our study, we observed that in-hospital mortality increased in multitrauma patients with a lactate value of >4.5. Also, in our study, in-hospital mortality was evaluated, not early mortality in the ED.

CONCLUSION

When SI and lactate parameters were used separately at the first admission to the hospital for a condition with high mortality such as multitrauma, it was observed that they predicted mortality significantly. We argue that early examination of these parameters in multitrauma patients admitted to the ED can determine the severity of the condition and may guide the patient management.

Limitations

Our study is retrospective, and it was conducted with a limited number of patients in a single center. We think that it is necessary to support our results with multicenter studies to be conducted with a larger patient population.

ETHICAL DECLARATIONS

Ethics committee approval: The study was approved by Ethics Committee of Balıkesir University Faculty of Medicine and was conducted in accordance with the principles of the Declaration of Helsinki (Decision date: December 8, 2021 and Issue: 2021/265).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version

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